

**Claims:**

What is claimed is:

1. A system for measuring a voltage in a body part, the system comprising

5 a multiplexing unit;

N body leads for electrically connecting the multiplexing unit to the body part; and

a controller switching unit for allowing a current to flow through the body part between two body leads,  $n_1$  and  $n_2$  of the N body leads, and a 10 resultant voltage to be measured between two body leads,  $n_3$  and  $n_4$  of the N body leads, where  $n_1 \neq n_2$  and  $n_3 \neq n_4$ , but where  $n_1$   $n_2$   $n_3$  and  $n_4$  need not otherwise be distinct.

2. The system of claim 1, wherein the multiplexing unit includes

15 a multiplexer; and

a first MX lead, a second MX lead, a third MX lead and a fourth MX lead for connecting the controller switching unit to the multiplexer.

3. The system of claim 2, wherein the controller switching unit includes

20 a first switch connected to the multiplexer by the first MX lead and the second MX lead;

a second switch connected to the multiplexer by the third MX lead and the fourth MX lead;

a current input lead connected to the first switch for injecting the current into the body part;

5 a current output lead connected to the second switch for receiving the current from the body part; and

a first voltage lead connected to the first switch and a second voltage lead connected to the second switch for measuring the resultant voltage.

10 4. The system of claim 3, wherein the controller switching unit can be in a bipolar mode, corresponding to  $n_1 = n_3$  or  $n_4$ , and  $n_2 = n_3$  or  $n_4$ , or a tetrapolar mode, corresponding to  $n_1$ ,  $n_2$ ,  $n_3$  and  $n_4$  being all distinct.

5. The system of claim 4, wherein, in the bipolar mode, the current input  
15 lead and the first voltage lead are electrically connected to each other and to exactly one of the first MX lead and the second MX lead, and the current output lead and the second voltage lead are electrically connected to each other and to exactly one of the third MX lead and the fourth MX lead.

20 6. The system of claim 4, wherein, in the tetrapolar mode, the current input lead is electrically connected to exactly one of the first MX lead and the second MX lead and the first voltage lead is electrically connected to the other

one of the first MX lead and the second MX lead, and the current output lead is electrically connected to exactly one of the third MX lead and the fourth MX lead and the second voltage lead is electrically connected to the other one of the third MX lead and the fourth MX lead.

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7. The system of claim 3, further comprising an internal load electrically connected to the first MX lead, the second MX lead, the third MX lead and the fourth MX lead, the internal load used for at least one of internal testing of the system and varying measurement range of the system.

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8. The system of claim 1, wherein the controller switching unit includes a controller for controlling switch states in the first switch and the second switch, and for controlling multiplexing states in the multiplexer.

15 9. The system of claim 1, wherein the body part is a breast.

10. The system of claim 1, further comprising an impedance module for generating the current for the input current lead and for measuring the resultant voltage, the impedance module calculating an impedance from the

20 current and the resultant voltage.

11. The system of claim 10, further comprising a diagnosis module for diagnosing the possibility of disease in the body part based on the impedance.

5 12. A method for measuring a voltage in a body part, the method comprising

providing a multiplexing unit;

connecting the body part to the multiplexing unit with N body leads;

sending a current through the body part between two body leads,  $n_1$

10 and  $n_2$  of the N body leads in response to control signals sent by a controller switching unit; and

measuring a resultant voltage between two body leads,  $n_3$  and  $n_4$  of the N body leads, where  $n_1 \neq n_2$  and  $n_3 \neq n_4$ , but where  $n_1$   $n_2$   $n_3$  and  $n_4$  need not otherwise be distinct.

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13. The method of claim 12, wherein the step of providing includes providing a multiplexer, the method further comprising

electrically connecting the controller switching unit to the multiplexer with a first MX lead, a second MX lead, a third MX lead and a fourth MX lead.

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14. The method of claim 13, further comprising

electrically connecting the multiplexer to a first switch in the controller switching unit with the first MX lead and the second MX lead;

electrically connecting the multiplexer to a second switch in the controller switching unit with the third MX lead and the fourth MX lead;

- 5        injecting the current into the body part with a current input lead that is connected to the first switch;

receiving the current from the body part with a current output lead that is connected to the second switch; and

- 10      measuring the resultant voltage with a first voltage lead connected to the first switch and a second voltage lead connected to the second switch.

15. The method of claim 14, further comprising placing the controller switching unit in a bipolar mode, corresponding to  $n_1 = n_3$  or  $n_4$ , and  $n_2 = n_3$  or  $n_4$ , or a tetrapolar mode, corresponding to  $n_1$ ,  $n_2$ ,  $n_3$  and  $n_4$  all being distinct.

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16. The method of claim 15, wherein the step of placing the controller switching unit in a bipolar mode includes

electrically connecting the current input lead and the first voltage lead to each other and to exactly one of the first MX lead and the second MX lead;  
20      and

electrically connecting the current output lead and the second voltage lead to each other and to exactly one of the third MX lead and the fourth MX lead.

5 17. The method of claim 16, wherein the step of placing the controller switching unit in a tetrapolar mode includes

electrically connecting the current input lead to exactly one of the first MX lead and the second MX lead;

10 electrically connecting the first voltage lead to the other one of the first MX lead and the second MX lead;

electrically connecting the current output lead to exactly one of the third MX lead and the fourth MX lead; and

electrically connecting the second voltage lead to the other one of the third MX lead and the fourth MX lead.

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18. The method of claim 14, further comprising providing an internal load electrically connected to the first MX lead, the second MX lead, the third MX lead and the fourth MX lead; and

20 using the internal load used for at least one of internal testing of the system and varying measurement range of the system.

19. The method of claim 12, wherein the body part is a breast.

20. The method of claim 12, further comprising  
generating the current for the input current lead with an impedance  
module;

5 measuring the resultant voltage with the impedance module; and  
calculating an impedance from the current and the resultant voltage.

21. The method of claim 20 further comprising diagnosing the possibility of  
disease in the body part based on the impedance.

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22. A system for measuring an electrical property in a body part, the  
system comprising

a multiplexing unit;  
N body leads for electrically connecting the multiplexing unit to the  
15 body part; and

a controller switching unit adapted to allow both bipolar and tetrapolar  
measurements using the N body leads.

23. A system for measuring an electrical property in a body part, the  
20 system comprising

a multiplexing unit;

N body leads for electrically connecting the multiplexing unit to the body part; and

- a controller switching unit adapted to allow a) a particular one of the N body leads to inject current into the body part for measuring a first resultant electrical property in a first measurement, and b) the particular one of the N body leads to measure a second resultant electrical property that results from injecting current into the body part in a second measurement.

24. The system of claim 23, wherein the first resultant electrical property is
- 10 a first resultant voltage, and the second resultant electrical property is a second resultant voltage.

25. A method for measuring a voltage in a body part, the method comprising

- 15 providing a multiplexing unit;
- connecting the body part to the multiplexing unit with N body leads;
- sending a current into the body part via a particular one of the N body leads to obtain a first resultant electrical property in a first measurement;
- injecting current into the body part in a second measurement; and
- 20 measuring a second resultant electrical property with the particular one of the N body leads in the second measurement.

26. The method of claim 25, wherein the first resultant electrical property is a first resultant voltage, and the second resultant electrical property is a second resultant voltage.